Optimum Thickness of Stearate "Gratings" for Soft X rays

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UNPUBLISHED PRELIMINARY DATA

Multilayered stearate and other fatty acid films[1] are proving to be very useful "pseudogratings" for the spectroscopy of the region from ca. 10 A. through the characteristic K radiation of boron (67.7 A.). They are readily made in the average laboratory and seem to be at least reasonably durable. In making them it is obviously important to know how many layers to deposit in order to get maximum intensities and minimal breadth in the spectral peaks. We have made such measurements of intensity and peak width from a series of pseudogratings having an increasing number of deposited films.

These gratings have consisted of lead stearate monolayers built up on a substrate of barium stearate with mica as a base. The gratings were employed flat in the windowless tube helium path spectrometer already described[2] in order to compare them with real crystals of long spacing. To permit such comparisons the x rays used were the relatively hard Kα spectral lines of Al (Kα = 8.32 A.) and Na(Kα = 11.88 A.).

The curves giving first order peak intensities as a function of number of monolayers in the grating for Al Kα from metallic aluminum and Na Kα from Na_2CO_3 are those of Figure 1; intensities are counts per second per watt of energy applied to the exciting x ray tube. For sodium x rays maximum peak intensities are provided by a 110 layer grating; perhaps fewer layers would be sufficient for longer wave lengths. For the more penetrating aluminum x rays the curve is still rising slowly for the 110 layer grating but such

short x rays are so rarely analyzed with these gratings that additional layers would be superfluous.

Potassium hydrogen phthalate with a 2d of 27 A. was compared with the pseudogratings by replacing them with a single crystal, all other conditions remaining unaltered; results are plotted along the appropriate ordinates of Figure 1. For Al $K\alpha$ the multilayered pseudograting with 110 layers is 2.5 times as effective for the organic salt and 4 times as effective for the longer sodium x rays.

Typical first order aluminum peaks from the phthalate crystal (KAP) and the pseudograting (LSD) are plotted in Figure 2. Their widths at half height with the slit system employed are almost identical: 2.30° for LSD and 2.33° for KAP. The asymmetry of the base line for the LSD is due to the very small 2θ angles; for higher orders the curves are symmetrical with peak-to-background ratios not less than 50:1.

The effect on line breadth of increasing the number of layers in the pseudograting is shown in Figure 3 where the peak width at half-height is plotted for the third order reflection of Na $K\alpha$. No absolute significance can be given these breadths but it is evident that they have reached their practical minimum with the 110 layer grating.

These observations were made in the laboratory of Ralph W.G. Wyckoff under support of National Aeronautics and Space Administration Grant NsG-120; we are indebted to him for many helpful suggestions.

[redacted]

Footnotes

1. K. B. Blodgett and I. Langmuir, Phys. Rev. 51, 964 (1937).

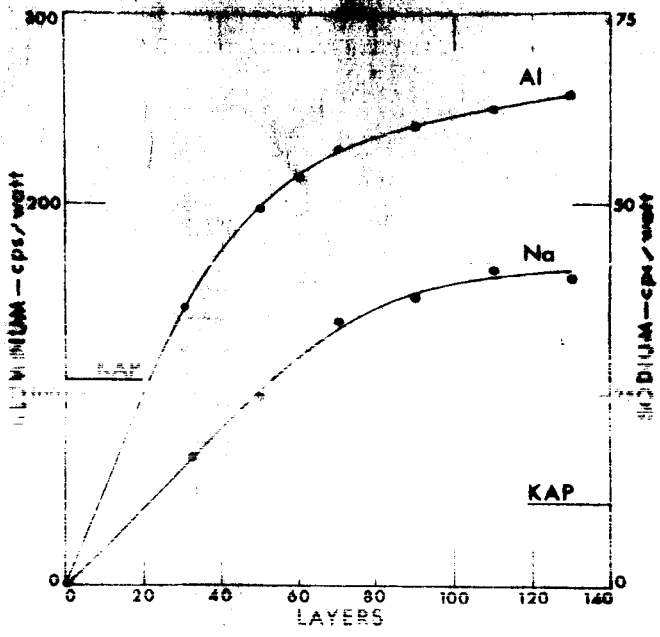
2. R. W. G. Wyckoff and F. D. Davidson, Rev. Sci. Instr. 35, 381 (1964).

Legends for Figures

Fig. 1. The intensity of x ray reflection as function of number of layers in the pseudograting. The values for a potassium acid phthalate crystal are given at the line marked KAP.

Fig. 2. Typical first order aluminum Kα peaks made with a potassium acid phthalate crystal (KAP) and a 120 layer lead stearate pseudograting (LSD).

Fig. 3. Half-width of reflection as influenced by the number of layers in the pseudograting.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Na
KAP
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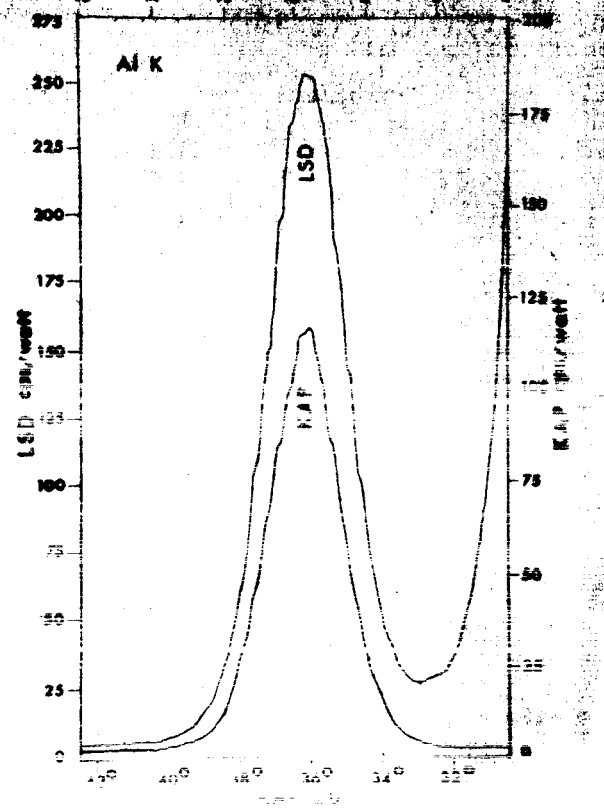
0
20
40
60
80
100
120
140
200
300
50
75

1


Al K
LSD
KAP
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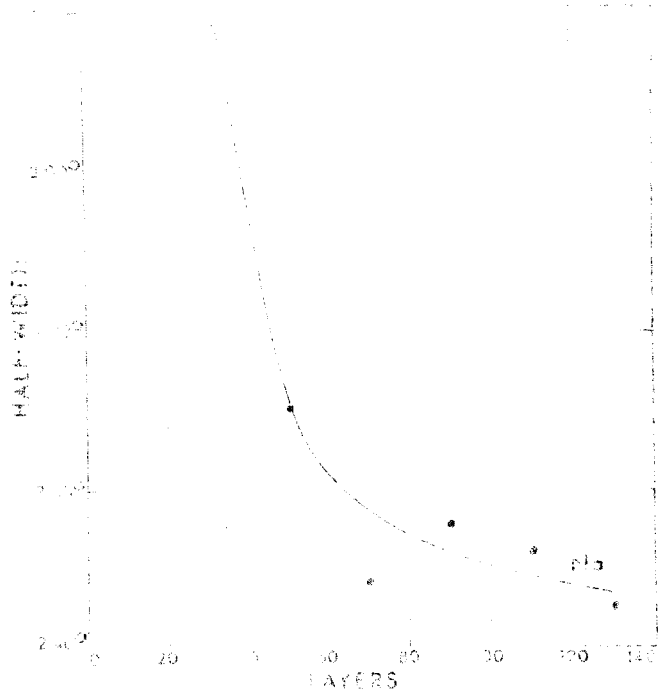
225
200
175
150
125
100
75
50
25
0
175
150
125
75
50

2


LAYERS

3